

OSA-2185-62

2 2



Westinghouse Electric Corporation

Air Arm Division

Friendship International Airport

Box 746, Baltimore 3, Md.

Telephone: 761-1000

November 13, 1962

Special Projects Office (ASZ-5)
Plans and Programs Office
Directorate of Production
Wright-Patterson AFB, Ohio

A186208

SUBJECT: Contract AF 33(600)-40280, Reduction
in Scope, Motion Compensation.
Westinghouse Ref. AAN-45196-20

Reference (a): Westinghouse Letter dated 27 August 1962, subject:
Contract AF 33(600)-40280, Program Extension.

Enclosure (1): Three (3) copies Westinghouse Specification R-1916, Rev.
A dated November 7, 1962 entitled "Antenna Angle and Motion
Compensation, Follower Version".

Enclosure (2): Three (3) copies Westinghouse Cost and Price Analysis,
Form FE-777-1 dated November 12, 1962.

Gentlemen:

The proposal submitted by Reference (a) and which subsequently was incorporated in the Contract by Amendment No. 13, included design and fabrication effort necessary to achieve motion compensation by roll stabilizing the linear cross track accelerometers and by stabilizing the antennas for two systems with a total estimated cost of \$ 142,283. (Refer to Item I, Section B of Reference (a)). Recent technical discussions have indicated the desirability of your directly procuring the signal sources, servos and actuators required for such motion compensation in accordance with a performance specification to be furnished by Westinghouse. Under this approach Westinghouse proposes to provide:

- (a) System design integration including the preparation of motion compensation performance specifications.
- (b) Liaison and design follow to assure overall system compatibility.
- (c) A mechanical preliminary design study for antenna angle control and design of servo installation on the radar frame.

25 YEAR RE-REVIEW

Attn: ASZ-5

-2-

November 13, 1962

The effort quoted for breadboard antenna stabilization and its evaluation quoted under Item 5, Section B, Flight Test, of Reference (a) is not affected by this proposal.


The performance specification has been developed based on several conferences with interested parties and is forwarded as Enclosure (1) for your review and consideration.

Our quotation for performing the effort outlined above is \$36,000 total estimated cost, and \$ 2,520 fixed fee. Enclosure (1) is an analysis of this quotation. Since this effort would replace that quoted under Item 1, Section B of Reference (a) for \$ 142,283 total estimated cost, the net reduction in total Contract Cost would be \$106,277.

Based on the fee negotiated for the SOARD Extension, the pro-rated fee for the \$142,283 total cost being deleted is \$ 8,878; therefore the net reduction in fee would be this figure less \$2,520 or \$ 6,358.

Technical coordination with interested groups is continuing pending your decision as to source for the motion compensation hardware. We have for the moment held work on its detailed design and fabrication as authorized by Amendment No. 13. If you adopt the proposal outlined herein, we will be glad to discuss the contractual arrangements at your convenience. However, because we are currently holding up authorized work which you may later procure elsewhere, an early decision on this proposal is desirable.

Very truly yours,
WESTINGHOUSE ELECTRIC CORPORATION


Project Liaison
Marketing Department

STAT

RWE:sf
Enc.

FORM AAE-54A

**Westinghouse ELECTRIC CORPORATION**

AIR ARM DIVISION

BALTIMORE MD. U.S.A.

ANTENNA ANGLE AND MOTION COMPENSATION

(FOLLOWER VERSION)

A	11-7-62		3,4,5,5		
REV. LETTER	DATE	CHANGE ORDER NO.	PAGES AFFECTED	BY	APPROVED
REVISIONS					
ORIGINAL					
PREPARED BY			CHECKED BY		
APPROVED			APPR		
APPROVED			APPROVED		
SHEET 1 OF 3 SHEETS		DATE 11-7-62	TOP DWG	SPEC. NO. R-1016	STAT

FORM AAE-55A

The purpose of this specification is to describe the functional units necessary to achieve compensation for aircraft motion. Section 1.0 includes the roll stabilized platform and related electronics to achieve compensated cross track acceleration of no more than 2 mill g or $1/16$ wavelength, whichever is the more severe limitation at a particular frequency of disturbance. Section 2.0 includes the electronics for antenna positioning in the yaw axis to maintain the beam center within 2 milliradians of the intended pointing direction independently of aircraft motion in pitch and yaw. The environmental limitations are also included.

1.0 CROSS TRACK VELOCITY COMPENSATION

See Figure 1

1.1 Roll Stabilized Platform

1.1.1	Outline limitation	Figure 2
1.1.2	Roll axis alignment to aircraft	1°
1.1.3	Accelerometer positioning relative to line of sight.	1 ft.
1.1.4	Accelerometer depression in roll	$29^\circ \pm 1^\circ$
1.1.5	Maximum roll rate	$10^\circ/\text{sec}$.
1.1.6	Maximum roll acceleration	$50^\circ/\text{sec}^2$
1.1.7	Positioning accuracy	.1 milliradian
1.1.8	Operating temperature range	-100°F to 300°F
1.1.9	Maximum temperature range	-54°F to 4300°F
1.1.10	Unattended service life	1000 hrs.

1.2 Integrator and Network

1.2.1	Maximum velocity	50 ft/sec
1.2.2	Velocity resolution	.01 ft/sec
1.2.3	Linearity	1%
1.2.4	Idealized network response	



Westinghouse ELECTRIC CORPORATION

AIR ARM DIVISION

BALTIMORE MD. U.S.A.

SHEET 3

SPEC. NO. R-1016

REV. A

FORM AAE-55A

$$F(s) = \frac{2\tau_1 s (1 + 1/2 \tau_1 s)}{(1 + \tau_1 s)^2} \times \frac{(1 + 3\tau_2 s)}{(1 + \tau_2 s)^3}$$

$$\tau_1 = 63.3 \text{ sec}$$

$$\tau_2 = .0106 \text{ sec}$$

1.2.5	Operating temperature range	+80° to +120°F
	Maximum temperature range	-55° to 120°F
1.3	Frequency Off-Set Generator	
1.3.1	Frequency range	+200 cps to +600 cps
1.3.2	Linear voltage range	+2.5 volt to -2.5v
1.3.3	Frequency resolution	.2 ft/sec
1.3.4	Linearity	1%
1.3.5	Frequency sensitivity	330 cps/volt
1.3.6	Input impedance	50k ohms
1.3.7	Operating temperature range	+80° to +120°F
1.3.8	Maximum temperature	-54° to +120°F
1.4	Accelerometer	
1.4.1	Maximum acceleration	1 G
1.4.2	Resolution	1 milli G
1.4.3	Linearity	1%
1.4.4	Upper frequency limit	20 cps
1.4.5	Operating temperature range	100° to 300°F
1.4.6	Maximum temperature range	-54° to 300°F



Westinghouse ELECTRIC CORPORATION

AIR ARM DIVISION

BALTIMORE MD. U.S.A.

SHEET 4

SPEC.
NO.

R-1016

REV
A

FORM AAE-55A

2.0 ANGLE COMPENSATION

Figure 1

- 2.1 Open loop antenna pointing error overall $\pm 6^\circ$ (30)
- 2.2 Antenna open loop response to aircraft motion 4 cps
- 2.3 Antenna system sensitivity at the input to the antenna follow servo 1 degree/volt
- 2.4 Summing point shall be capable of accepting a signal from the doppler tracker (output impedance $< 500 \sim$) and summing it with the open loop commands with unity gain.
- * 2.5 Operating temperature range. $+80^\circ$ to $+120^\circ\text{F}$
- 2.7 Maximum temperature range -54° to $+140^\circ\text{F}$
- 2.8 Position potentiometer
 - 2.8.1 Operating temperature range 100°F to 450°F
- * 2.5 The doppler frequency tracker will close the antenna pointing loop at low frequencies with a gain in excess of 5 volt/arc and with unity gain at 1/10 cps.



Westinghouse ELECTRIC CORPORATION

AIR ARM DIVISION

BALTIMORE MD. U.S.A.

SHEET 5

SPEC.
NO.

R-1916

REV

A

FORM AAE-55A

3.0 GENERAL

- 3.1 The environmental conditions except temperature and detailed in R-1611.
- 3.2 In the event of conflict between this document and any MIL Specification this document shall govern.



Westinghouse ELECTRIC CORPORATION
AIR ARM DIVISION BALTIMORE MD. U.S.A.

SHEET 6

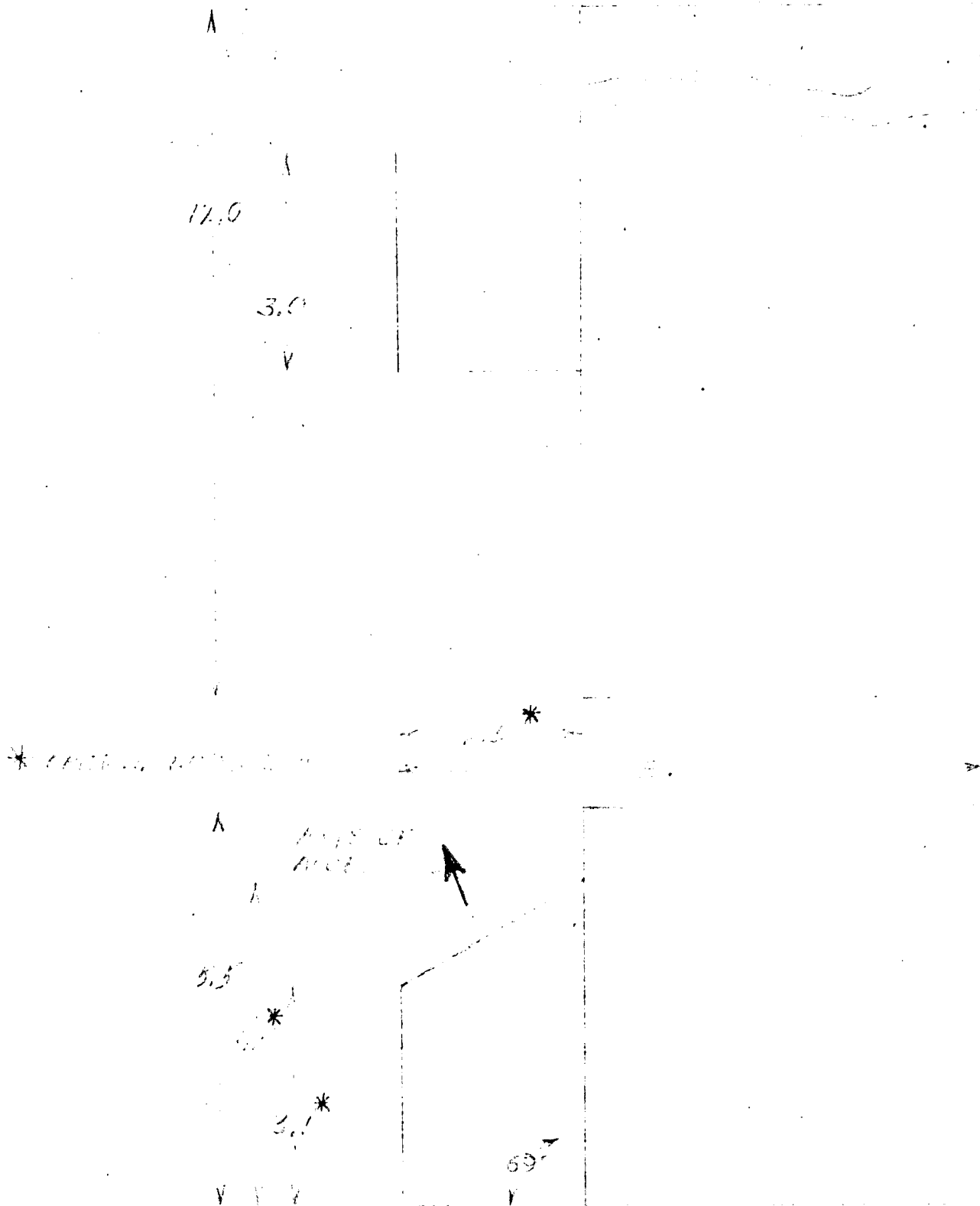
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REV
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FORM AAE-55A



AIR ARM DIVISION

Westinghouse ELECTRIC CORPORATION

BALTIMORE MD. U.S.A.

SHEET 8

SPEC. NO. R-1816

REV

FE-772-1

ESTIMATED COST ☐ HISTORICAL COST ☐

Encl(2)

NAME OF CONTRACTOR
Westinghouse Electric Corporation - Air Arm Division

ADDRESS (STREET)
P.O. Box 746

PRIME ☒ SUB ☐

CITY
Baltimore

ZONE
3

STATE
Maryland

ORDER OR FILE NO.
AAH-45196-20

CONTRACT NO.
AF33(600)-40280

ITEM NO.
A11

ARTICLE
Motion Compensation System Investigation, Follow

QUANTITY

AT

AMOUNT

TERMS AND DISCOUNT
and Mech. Study

\$ EACH \$ **38,526**

NET TOTAL OF CONTRACT

ANALYSIS OF PRICE AS OF

November 12, 1962

TYPE OF CONTRACT

CPTT

INDICATE WHETHER DATA BELOW IS:

PER UNIT ☐

OR TOTAL ☒

LINE	ITEM		AMOUNT
1.	MANUFACTURING COST - DIRECT:		
A.	DIRECT MATERIAL	X X X X X	X X X X X
B.	FACTORY LABOR (HOURS)		X X X X X
C.	FACTORY OVERHEAD		X X X X X
D.	TOOLS, DIES, JIGS, PATTERNS & FIXTURES		X X X X X
E.	OTHER (SCHEDULE ATTACHED)		X X X X X
F.	TOTAL DIRECT MANUFACTURING COST		X X X X X
2.	PRODUCT DEVELOPMENT (% OF 1F)	X X X X X	
3.	ENGINEERING COST - DIRECT:	X X X X X	
A.	DIRECT MATERIAL	X X X X X	X X X X X
B.	ENGINEERING LABOR (3,055 HOURS)		X X X X X
C.	ENGINEERING OVERHEAD	\$ 15,020	X X X X X
D.	OTHER (SCHEDULE ATTACHED) Travel	12,289	X X X X X
E.	TOTAL DIRECT ENGINEERING COST	4,535	X X X X X
4.	GENERAL RESEARCH (4.5 % OF 1F + 2 + 3E)	X X X X X	\$31,844
5.	TOTAL MANUFACTURING & ENGINEERING COST (1F + 2 + 3E + 4)		1,433
6.	GENERAL AND ADMINISTRATIVE EXPENSE (8.2 % OF 5)		33,277
7.	CONTINGENCIES (FURNISH DETAILS)		2,729
8.	OTHER EXPENSES (FURNISH DETAILS)		
9.			
10.			
11.	TOTAL COST (SUM OF LINES 5 THRU 10)		36,006
12.			
13.	OPERATING PROFIT OR FIXED FEE		2,520
14.			
15.			
16.	TOTAL ESTIMATED COST INCLUDING FIXED FEE - COST TYPE CONTRACTS		
17.	SELLING PRICE - FIXED PRICE CONTRACTS		\$ 38,526
18.			
19.			
20.			

SEE DESCRIPTION OF COST AND PRICE ANALYSIS PROCEDURE

The subcontracted portion of this contract is estimated at _____ % of selling price.

CERTIFICATION

This is to certify that the above information contained in this report has been compiled from the records and books of this company (or is an estimate based on such books and records) and to the best of our knowledge and belief the costs and expenses shown hereon are correct.

STAT

Westinghouse Electric Corp. - Air Arm Div.

CONTRACTOR

November 13, 1962

DATE

ing Department

Manager, Accounting Department.

STAT

Enclosure (1)

AAH-45196-20 - 13 November 1962

1962

	<u>Manhours</u>	<u>Labor Rate</u>	<u>Overhead Rate</u>	<u>Labor and Overhead Dollars</u>
Support & Evaluation	1,400	\$ 4.99	\$3.82	\$ 12,334
Mech. Design & Development	795	5.10	3.71	7,004

NOTE: Engineering Labor Adjustment of 0.9% to be applied to above rates

1961

	<u>Manhours</u>	<u>Labor Rate</u>	<u>Overhead Rate</u>	<u>Labor & Overhead Dollars</u>
Support & Evaluation	600	\$ 4.99	\$3.82	\$ 5,286
Mech. Design & Development	260	5.10	3.71	2,291

NOTE: Engineering Labor Adjustment of 2.9% to be applied to above rates.

FE-777-1

ESTIMATED COST COST

encl(2)

NAME OF CONTRACTOR

Westinghouse Electric Corporation - Air Arm Division

PRIME ☒SUB ☐

ADDRESS (STREET)

P.O. Box 746

PURCHASE REQUISITION NO.

CITY

Baltimore

ZONE

3

STATE

Maryland

ORDER OR FILE NO.

AAM-45196-20

CONTRACT NO.

AF33(600)-40280

ITEM NO.

A11

ARTICLE

Motion Compensation System Investigation, Follow

QUANTITY

AT

AMOUNT

\$

EACH \$

38,526

TERMS AND DISCOUNT

and Mech. Study

NET TOTAL OF CONTRACT

\$

ANALYSIS OF PRICE AS OF

November 12, 1962

TYPE OF CONTRACT

CPTT

INDICATE WHETHER DATA BELOW IS:

PER UNIT ☐OR TOTAL ☒

LINE	ITEM		AMOUNT
1.	MANUFACTURING COST - DIRECT:		
A.	DIRECT MATERIAL	X X X X X	X X X X X
B.	FACTORY LABOR (HOURS)		X X X X X
C.	FACTORY OVERHEAD		X X X X X
D.	TOOLS, DIES, JIGS, PATTERNS & FIXTURES		X X X X X
E.	OTHER (SCHEDULE ATTACHED)		X X X X X
F.	TOTAL DIRECT MANUFACTURING COST	X X X X X	X X X X X
2.	PRODUCT DEVELOPMENT (% OF 1F)	X X X X X	
3.	ENGINEERING COST - DIRECT:		
A.	DIRECT MATERIAL	X X X X X	X X X X X
B.	ENGINEERING LABOR (3,055 HOURS)	\$ 15,020	X X X X X
C.	ENGINEERING OVERHEAD	12,289	X X X X X
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Westinghouse Electric Corp. - Air Arm Div.

November 13, 1962

Enclosure

SIGNATURE AND TITLE

- Manager, Marketing Department

STAT

SIGNATURE AND TITLE

Manager, Accounting Department

AAH-45196-20 - 13 November 1962

		<u>1962</u>		
	<u>Manhours</u>	<u>Labor Rate</u>	<u>Overhead Rate</u>	<u>Labor and Overhead Dollars</u>
Support & Evaluation	1,400	\$ 4.99	\$3.82	\$ 12,334
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	<u>Manhours</u>	<u>Labor Rate</u>	<u>Overhead Rate</u>	<u>Labor & Overhead Dollars</u>
Support & Evaluation	600	\$ 4.99	\$3.82	\$ 5,286
Mech. Design & Development	260	5.10	3.71	2,291

NOTE: Engineering Labor Adjustment of 2.9% to be applied to above rates.



AIR ARM DIVISION

(FOLLOWER VERSION)

FORM AAE-55A

The purpose of this specification is to describe the functional units necessary to achieve compensation for aircraft motion. Section 1.0 includes the roll stabilized platform and related electronics to achieve compensated cross track acceleration of no more than 2 mill g or 1/16 wavelength, whichever is the more severe limitation at a particular frequency of disturbance. Section 2.0 includes the electronics for antenna positioning in the yaw axis to maintain the beam center within 2 milliradians of the intended pointing direction independently of aircraft motion in pitch and yaw. The environmental limitations are also included.

1.0 CROSS TRACK VELOCITY COMPENSATION

See Figure 1

1.1 Roll Stabilized Platform

1.1.1	Outline limitation	Figure 2
1.1.2	Roll axis alignment to aircraft	1°
1.1.3	Accelerometer positioning relative to line of sight.	1 ft.
1.1.4	Accelerometer depression in roll	29° ±1°
1.1.5	Maximum roll rate	10°/sec.
1.1.6	Maximum roll acceleration	50°/sec ²
1.1.7	Positioning accuracy	.1 milliradian
1.1.8	Operating temperature range	-100°F to 300°F
1.1.9	Maximum temperature range	-54°F to +300°F
1.1.10	Unattended service life	1000 hrs.

1.2 Integrator and Network

1.2.1	Maximum velocity	50 ft/sec
1.2.2	Velocity resolution	.01 ft/sec
1.2.3	Linearity	1%
1.2.4	Idealized network response	



Westinghouse ELECTRIC CORPORATION
AIR ARM DIVISION
BALTIMORE MD. U.S.A.

SHEET 3

SPEC. NO. R-1916

REV
A

FORM AAE-55A

$$F(s) = \frac{2\tau_1 s (1 + 1/2 \tau_1 s)}{(1 + \tau_1 s)^2} \times \frac{(1 + 3\tau_2 s)}{(1 + \tau_2 s)^3}$$

$$\tau_1 = 63.3 \text{ sec}$$

$$\tau_2 = .0106 \text{ sec}$$

- | | | |
|-------|-----------------------------|----------------------|
| 1.2.5 | Operating temperature range | +80° to +120°F |
| | Maximum temperature range | -55° to 120°F |
| 1.3 | Frequency Off-Set Generator | |
| 1.3.1 | Frequenc, range | +200 cps to +600 cps |
| 1.3.2 | Linear voltage range | +2.5 volt to -2.5v |
| 1.3.3 | Frequency resolution | .2 ft/sec |
| 1.3.4 | Linearity | 1% |
| 1.3.5 | Frequency sensitivity | 330 cps/volt |
| 1.3.6 | Input impedance | 50k ohms |
| 1.3.7 | Operating temperature range | +80° to +120°F |
| 1.3.8 | Maximum temperature | -54° to +120°F |
| 1.4 | Accelerometer | |
| 1.4.1 | Maximum acceleration | 1 G |
| 1.4.2 | Resolution | 1 milli G |
| 1.4.3 | Linearity | .1% |
| 1.4.4 | Upper frequency limit | 20 cps |
| 1.4.5 | Operating temperature range | 100° to 300°F |
| 1.4.6 | Maximum temperature range | -54° to 300°F |



Westinghouse ELECTRIC CORPORATION
AIR ARM DIVISION BALTIMORE MD. U.S.A.

SHEET 4

SPEC.
NO. R-1,16REV.
A

FORM AAE-55A

2.0 ANGLE COMPENSATION

- Figure 1
- 2.1 Open loop antenna pointing error overall $\pm .6^\circ (3\sigma)$
 - 2.2 Antenna open loop response to aircraft motion 4 cps
 - 2.3 Antenna system sensitivity at the input to the antenna follow servo 1 degree/volt
 - 2.4 Summing point shall be capable of accepting a signal from the doppler tracker (output impedance $< 500 \sim$) and summing it with the open loop commands with unity gain.
 - * 2.6 Operating temperature range $+80^\circ +120^\circ\text{F}$
 - 2.7 Maximum temperature range $-54^\circ +140^\circ\text{F}$
 - 2.8 Position potentiometer
 - 2.8.1 Operating temperature range $100^\circ\text{F to } 450^\circ\text{F}$
 - * 2.5 The doppler frequency tracker will close the antenna pointing loop at low frequencies with a gain in excess of 1 volt/ke and with unity gain at 1/10 cps.



Westinghouse ELECTRIC CORPORATION
AIR ARM DIVISION
BALTIMORE MD. U.S.A.

SHEET 5

SPEC.
NO.

R-1,16

REV

A

FORM AAE-55A

3.0 GENERAL

- 3.1 The environmental conditions except temperature and detailed in R-1811.
- 3.2 In the event of conflict between this document and any MIL Specification this document shall govern.



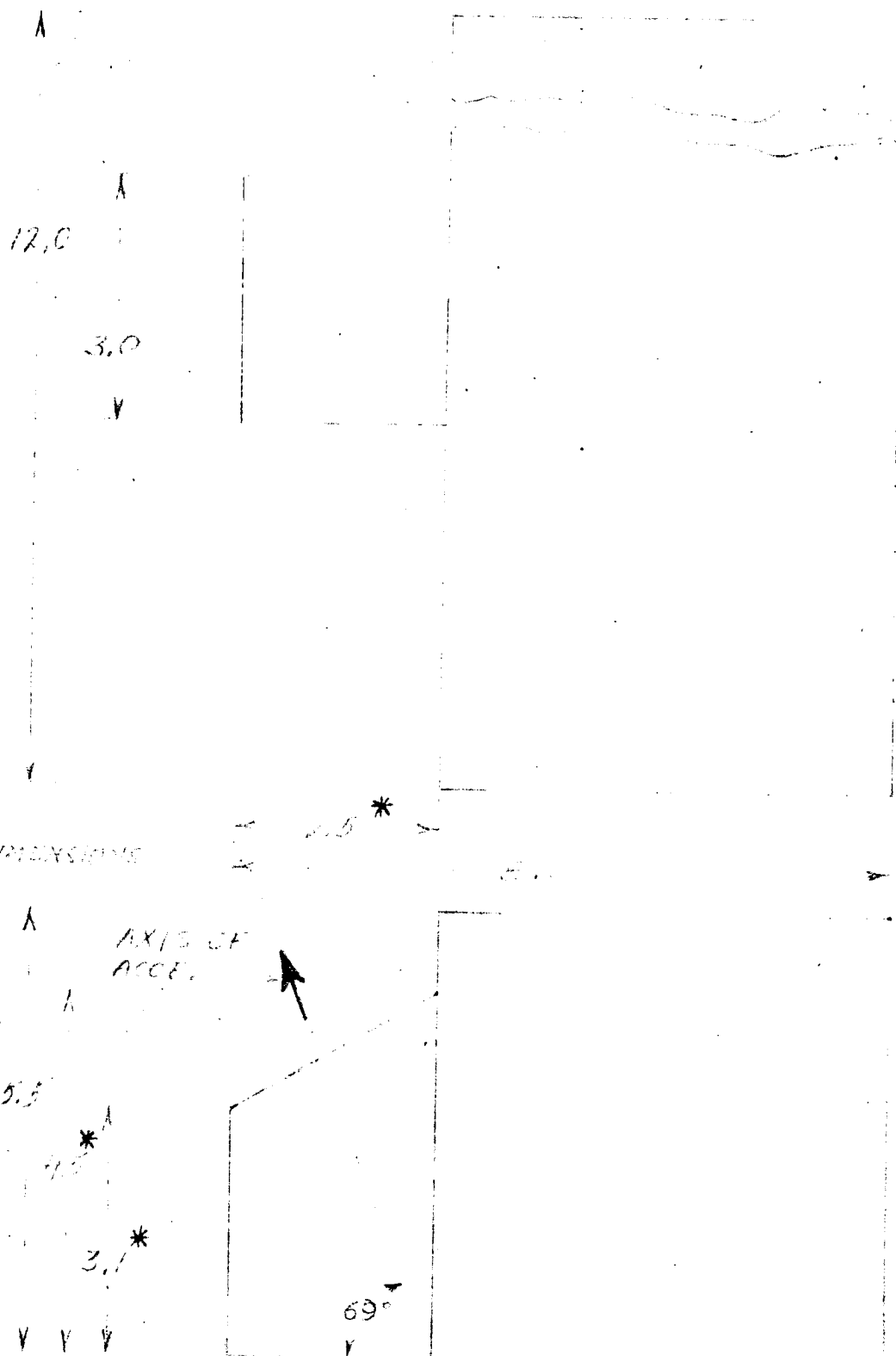
Westinghouse ELECTRIC CORPORATION
AIR ARM DIVISION BALTIMORE MD. U.S.A.

SHEET 6

SPEC.
NO. R-1916

REV
A

FORM AAE-55A



Westinghouse ELECTRIC CORPORATION
AIR ARM DIVISION BALTIMORE MD. U.S.A.

SHEET 8

SPEC. NO. R-1916

REV

PAGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
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PAGE	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
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MOTION COMPENSATION by angle reference

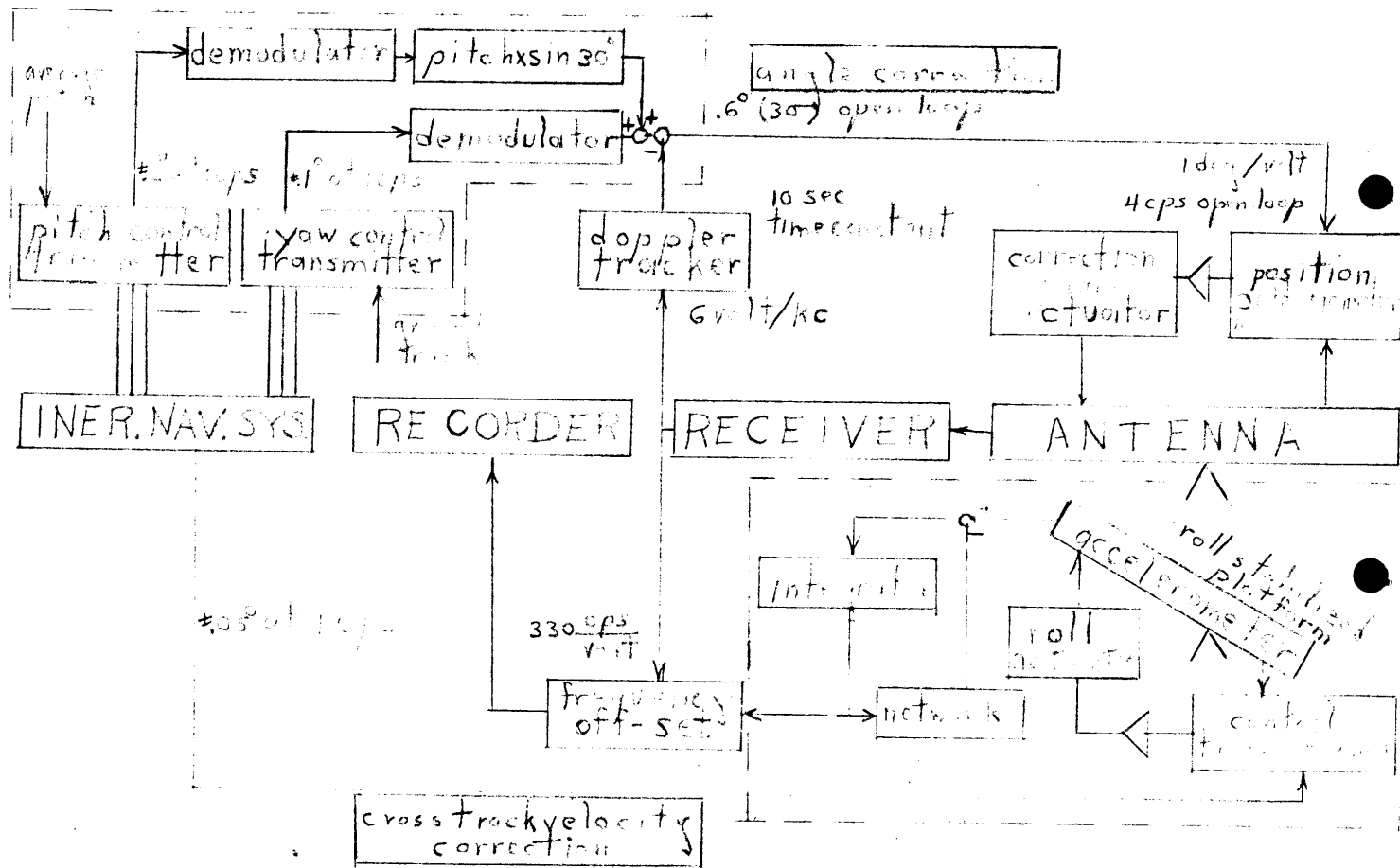


Fig 1

10/18/62
M.S. Wheeler